

wherein:

M comprises a transition metal;

R comprises an alkyl, alkenyl, alkynyl, aryl, alkoxy, alkenyloxy, alkynyloxy, aryloxy, alkoxy carbonyl, alkylamino, alkylthio, alkylsulfonyl, alkylsulfinyl; each optionally substituted with an alkyl, halogen, alkoxy, aryl or heteroaryl moiety;

C, R₁ and R₂ each comprises or together comprise, an electron withdrawing anionic ligand;

a, b, c, and d each comprise H, a halogen atom or an alkyl, alkenyl, alkynyl, aryl, alkoxy, alkenyloxy, alkynyloxy, aryloxy, alkoxy carbonyl, alkylamino, alkylthio, alkylsulfonyl; each optionally substituted with an alkyl, halogen, aryl or heteroaryl moiety;

X is oxygen, sulfur, nitrogen or phosphorus; and

Y comprises an electron-donating heterocyclic carbene ligand.

11. (Amended) The composition of claim 10 wherein R₃ and R₄ both comprise 2,4,6-trimethylphenyl (mesityl) moieties.

16. (Amended) The composition of claim 14 wherein M is a transition metal selected from the group consisting of ruthenium, osmium and tungsten.

17. (Amended) The composition of claim 14 wherein M is ruthenium.

31. (Amended) The transition metal catalyst of claim 30 comprising at least one substituent that is capable of reacting with functional groups on the substrate surface so as to render said catalyst chemically bonded to said substrate surface.

34. (Amended) A composition of claim 1 wherein said catalyst is capable of chemically bonding to a substrate surface.

36. (Amended) A composition of claim 30 wherein the substrate is glass, metal, non-metal, ceramics, rubber or a polymeric material.

39. (Amended) A method of immobilizing the transition metal catalyst of claim 1 comprising the steps of

i) reacting said catalyst with a chemical coupling agent under conditions to form an adduct with said catalyst so as to render it capable of attachment to a substrate surface, and

ii) contacting said adduct with a substrate or a substrate surface under conditions to cause said adduct to become chemically bound to said substrate surface through covalent chemical bonding, ionic bonding, non-ionic interaction, or combinations thereof.

43. (Amended) The method of claim 39 wherein said transition metal catalyst is reacted with a plurality of chemically different coupling agents.

45. (Amended) The method of claim 39 wherein said substrate material is a porous or non-porous material.

46. (Amended) The method of claim 45 wherein said substrate material is a porous sol-gel.